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Further Note on the Position of the Sun's Axis of Rotation, as deduced from Greenwich Sun-spot Measures 1874–1885. *Papers of the I.U.S.R. Computing Bureau, No. II.* By H. H. Turner, D.Sc., F.R.S., Savilian Professor.

1. This note gives for the period 1874–1885 computations similar to those given for the period 1886–1901 in the December No. (p. 98). The discussion is limited to spot-groups which live for ten days. The tables are numbered to correspond with those of the former note.

Table I.

Latitude drift between +65° *and* −65° *in each month* (*of the years* 1874–1885).

Latitude.	−25°	−20°	−15°	−10°	0°	+10°	+15°	+20°	+25°	
Jan.	+57	+170	−64	−19	−33	+25	00	−21	—	+5
Feb.	+113	−41	−48	−61	+62	−29	+50	−16	+77	+70
Mar.	−27	+145	+15	+45	+16	+30	+80	+97	—	—
Apr.	−55	+100	+79	+23	+34	+55	+113	+61	+118	—
May	−85	—	+12	+39	+45	+5	+62	−22	+10	+5
June	—	−171	+43	+31	−50	+70	−61	+125	+73	+125
July	−23	—	−33	−97	−18	+5	−52	−116	−2	+115
Aug.	—	+15	+35	+28	+17	−34	+27	+23	+57	−5
Sept.	+35	−90	−11	−136	+8	+31	−55	+11	+38	0
Oct.	—	−13	+18	+57	−38	−53	−4	+46	+53	—
Nov.	—	−37	+60	+12	−11	−17	−52	−7	−83	—
Dec.	−75	—	+62	+240	−25	+33	−80	−54	−1	+215
Mean	—	—	+14	+14	+1	+10	+2	+11	—	—

The unit in the tables is 0°·01, and the figures are, in Table I., differences between the mean residual at +65° and −65° in

Table II.

Latitude drift between +35° *and* −35° *in each month* (*of the years* 1874–1885).

Latitude.	−25°	−20°	−15°	−10°	0°	+10°	+15°	+20°	+25°	
Jan.	+48	+95	+25	+12	−37	+25	−29	−53	—	+15
Feb.	+50	−6	−51	−30	+20	+23	+3	−5	+40	+152
Mar.	+32	+71	−6	+32	+23	+39	+70	−2	—	—
Apr.	−35	+80	+49	+12	−1	+7	+33	+10	+98	—
May	−87	+10	+24	+31	+36	−31	+31	+68	+50	+88
June	+12	−70	+10	+34	+61	+60	−23	+75	+43	+135
July	+51	−88	−1	−16	+25	−10	−10	−38	+12	+87
Aug.	—	+47	+15	−26	+10	−63	+6	+90	+8	+15
Sept.	+2	−6	−24	−87	+26	−4	+3	+8	+41	+12
Oct.	—	+5	+9	+25	+4	−25	−15	+5	+10	—
Nov.	—	−43	+74	+17	−1	−67	−15	+2	−58	—
Dec.	−15	—	+43	+137	+30	+59	−88	−194	+22	+67
Mean	—	—	+14	+12	+16	+1	−3	−3	—	—

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longitude from the centre of the disc; and in Table II., similar differences for longitudes ± 35° from the centre.

Excluding,* at any rate in the first instance, the outside groups (for latitudes above 20°), we can now analyse the remaining 6 columns in each table harmonically, to find an expression of the form

$$A \sin \theta + B \cos \theta + C,$$

where $\theta = 0$ for the middle of January.

Multiplying the coefficients A and B by $\frac{1}{2}$ cosec 65° for Table I., and $\frac{1}{2}$ cosec 35° for Table II., we get the error of the Sun's axis, which we may now express (as Carrington does) in minutes of arc. The separate determinations are given in Table III.

TABLE III.

Quantities representing the Errors of the Sun's adopted axis.

Latitudes.	−20°	−15°	−10°	0°	+10°	+15°	+20°	Mean.
A from Table I.	−0′·5	−0′·1	+7′·5	+8′·0	+19′·6	+8′·0		+7′·1
A ,, ,, II.	−3·3	+4·3	+3·9	+12·6	+15·5	+12·2		+7·5
B ,, ,, I.	−2·7	+14·3	+1·2	−1·0	+3·9	−2·4		+2·2
B ,, ,, II.	+2·8	+14·5	−8·8	+9·8	−5·9	−32·2		−3·3

Inspection of Table III. suggests the following conclusions:—

(*a*) The accordance between determinations from meridians ± 65° and ± 35° is not so marked as before; but the discordances are not systematic. We must remember that the former series was based on 16 years' observations, and the present on less than 11 years'.

(*b*) The mean error of the adopted axis in A is confirmed within very narrow limits, the mean value of A being + 7′·3 as against + 7′·4 for the period 1886–1901. But the mean value of B for the same period was − 7′·8, whereas the measures here discussed give nearly zero. Can we ascribe this difference to accidental error? It is possible that B is more liable to error than A, owing to the fact that its coefficient is large in December and June, and it gets the full effect of any difference between summer and winter. If, for instance, there are fewer good photographs taken at Greenwich during the winter, there will be more Indian used in the series; and any differences between the two would have maximum effect. Such points must be separately examined. Meanwhile, we may remark that the arithmetical sum of the differences between pairs of values of B from Tables I. and II. in the present paper is 66′·1 as against 23′·7 for A; in

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* In the former paper two sentences have here been inadvertently transposed. They are repeated here in the correct order.

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the former paper these numbers were 20′·7 and 14′·3; so that there is some reason for regarding A as better determined than B, and also for regarding the former results as entitled to greater weight than the present. The best provisional determination of the errors of Carrington's axis, assuming that it remained fixed in space during the period 1874–1901, would therefore be

$$A = +7' \qquad B = -5'$$

giving double weight to the results of the former paper.

(*c*) As regards the discordances between the different zones, we may compare the results of the former paper and the present as follows:—

	A			B		
	−20° to −10°	to +10°	to +20°	−20° to −10°	to +10°	to +20°
1874–1885	+0·1	+8·0	+13·8	+7·2	+0·3	−9·2
1886–1901	+3·2	+5·8	+13·3	−1·3	−13·5	−8·7
Weighted Mean	+2·2	+6·5	+13·5	+1·5	−8·9	−8·9

double weight being given to the second series in taking the mean.

(*d*) We now come to the constant C, the mean value of which is positive (as already remarked in a note on p. 103 of the last paper), instead of negative as before. Rearranging the material in consecutive years, as in the former paper, we get

TABLE IV.

Drift in Latitude between +65° *and* −65° *from central meridian.*

Year.	−25°	−20°	−15°	−10°		0°	+10°	+15°	+20°	+25°
1874	—	—	$+54_3$	$+63_3$	-45_4	$+70_6$	-61_4	-245_2	—	—
1875	—	—	—	$+75_5$	$+87_4$	-34_5	0_1	$+67_2$	—	—
1876	—	—	—	-112_4	$+55_2$	—	$+57_2$	—	—	—
1877	—	—	—	$+20_1$	—	-6_5	$+90_1$	—	—	—
1878	—	—	—	—	—	$+46_2$	$+5_1$	—	—	—
1879	—	$+45_1$	—	—	—	—	—	—	—	-80_1
1880	$+31_3$	-171_3	$+19_9$	$+40_1$	—	—	$+100_3$	-4_6	$+49_{12}$	$+13_3$
1881	$+40_2$	$+38_3$	-5_7	$+142_2$	$+203_1$	-35_1	-41_{12}	$+22_9$	$+18_{10}$	$+86_5$
1882	-72_2	-14_6	$+82_{10}$	$+64_{12}$	-38_5	$+33_5$	$+11_{12}$	$+21_9$	$+21_7$	—
1883	$+13_2$	-23_8	$+5_{16}$	$+50_{14}$	-52_{17}	0_7	-5_{16}	$+37_3$	—	—
1884	-27_1	$+45_1$	$+51_8$	-1_{15}	$+24_{22}$	-12_{22}	$+46_{19}$	-22_3	—	—
1885	—	$+27_3$	-9_{15}	-19_{18}	$+25_{15}$	$+10_{12}$	$+5_{14}$	-27_2	—	—

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In Table V. the results of the former paper are repeated, so as to show the annual results for the whole series of years.

TABLE V.

Year.	Mean Drift.	No. Spots.	Year.	Mean Drift.	No. Spots.
1874	−7	22	1888	−90	10
1875	+40	17	1889	−34	10
1876	−28	8	1890	−3	6
1877	+11	7	1891	−2	57
1878	+32	3	1892	−30	107
1879	−18	2	1893	−19	135
1880	+17	40	1894	−24	118
1881	+18	52	1895	−40	94
1882	+27	68	1896	−39	49
1883	−4	83	1897	−39	44
1884	+16	91	1898	−47	32
1885	+2	79	1899	+21	14
1886	−4	37	1900	−7	9
1887	0	18	1901	+50	3

The unit of the table is 0°·01, and the drift tabulated takes place in 130° of longitude. The figures have not yet been corrected for error of the Sun's axis, so that the results for years with few spots are subject to sensible corrections, depending on the particular months in which the spots were visible.

But the main feature of the table seems to be an oscillation from a drift of about +20, or +33′ per rotation, in 1880 to an opposite drift of −25, or −40′ per rotation in about 1893.

Now one possible explanation of these figures is that the Sun's axis is not stationary, but is describing a cone in space, in a period which may be one of several.

(α) If the period were about 26 years, the effect would be reversed in 13 years, but it is easily seen that the angular radius of the cone would have to be too large to fit the facts.

(β) If the period were nearly a submultiple of a year, say six months, Tables I. and II. would show it. Analysis does not yield a suitable result.

(γ) It seems most likely that the period is nearly a year. If it were exactly a year, and we had adopted a wrong axis so as to get an apparent drift in latitude, the error and its effects would travel round with the Earth, so that we should get a spurious constant drift. If the period differs from a year, the spurious drift would slowly change, going through a complete cycle in the L.C.M. of the period and the year. For instance, if the cycle is about 26 years, the period of the wobble of the Sun's axis must differ from one year by about half a month.

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(δ) The drift may, however, be a physical drift on the surface of the Sun; and we can distinguish between these rival hypotheses by examining spots which return after disappearing. If the drift is physical, it will persist on the side of the Sun remote from the Earth; if due to the rotation of the axis, it will be reversed on the other side. Since the amount per rotation is large near a maximum (say 40′ per rotation), even a cursory examination should settle the point. Carrington's observations show no tendency to physical drift, as may easily be seen from the results 130 to 213, or the table pp. 213–219, or the summary on p. 220. Nor does an examination of the spot returns tabulated by Father Corte (*Mon. Not.*, vol. lx.) give much support to the hypothesis of a physical drift.

On the whole, hypothesis (γ) seems best worthy of further study.

But before deducing definitive elements for the axis, we await the results deduced from the measures of C. H. F. Peters, and recently published by Professor Frost. These are nearly completed, and can probably be given in the next number of the *Monthly Notices.*

Magnitude of η Argus, 1908. By R. T. A. Innes.

Comparison star used, Gilliss 1332 of 7·6 mag., yellowish or reddish, 4 on Chandler's colour-scale. This star is 8′ N.pr. η Argus.

1908.	Mag.	Colour.
Apr. 2	7·8	5
7	7·8	
13	7·7	6
June 2	7·7	6
Mean	7·75	5·7

A low-power field, with both stars in view, on the 9-inch refractor.

Johannesburg:
1908 *June* 3.